GCSE

Accreditation

Subject Criteria and Requirements

MATHEMATICS

December 2015

Contents

The criteria

Introduction

Subject criteria set out for all GCSE specifications the:

- knowledge and understanding, and skills; and
- Assessment Objectives (AOs) and assessment arrangements.

Along with the GCSE Design Principles, they provide the framework to support Awarding Organisations in the development of their GCSE specifications.

Aims and learning outcomes

1. The GCSE specification in Mathematics must provide a broad, coherent, satisfying and worthwhile course of study that will motivate learners and enable them to progress with confidence to further study and/or employment. It must enable learners to make appropriate judgements about choice and use of Functional Mathematics across the curriculum. The specification must build on the knowledge, understanding and skills established through the Northern Ireland Curriculum at Key Stage 3.

2. The GCSE specification in Mathematics must enable learners to:

   - be confident in handling numbers and have a good mathematical awareness and how this can be applied in practical contexts;
   - develop knowledge, skills and understanding of mathematical methods and concepts;
   - acquire and use problem-solving strategies;
   - select and apply mathematical techniques and methods in everyday and real-life situations;
   - reason mathematically by making deductions and inferences and drawing conclusions;
   - interpret and communicate mathematical information in a variety of forms appropriate to the information available and within appropriate context.

Subject content

3. The content of the GCSE specification must reflect the learning outcomes and be consistent with the statutory requirements of the Northern Ireland Curriculum at Key Stage 4.

4. The GCSE specification in Mathematics must enable learners to develop the knowledge, skills and understanding specified below.

Number

- add, subtract, multiply and divide any number;

- order rational numbers;
- use the concepts and vocabulary of factor (divisor), multiple, common factor, highest common factor, least common multiple, prime number and prime factor decomposition;
- use the terms square, positive and negative square root, cube and cube root;
- use index notation for squares, cubes and powers of ten;
- use index laws for multiplication and division of integer, fractional and negative powers;
- interpret, order and calculate with numbers written in standard index form;
- understand equivalent fractions, simplifying a fraction by cancelling all common factors;
- add and subtract fractions;
- use decimal notation and recognise that each terminating decimal is a fraction;
- recognise that recurring decimals are exact fractions, and that some exact fractions are recurring decimals;
- understand that 'percentage' means 'number of parts per 100' and use this to compare proportions;
- understand and use number operations and the relationships between them, including inverse operations and hierarchy of operations;
- use surds and π in exact calculations;
- calculate upper and lower bounds;
- approximate to specified or appropriate degrees of accuracy including a given power of ten, number of decimal places and significant figures;
- use calculators effectively and efficiently, including statistical and trigonometrical functions;
- understand the principles of number systems;
- convert numbers from Decimal to Binary (base 2) and vice versa;
- divide a quantity in a given ratio;
- use percentages;
- use repeated proportional change;
- understand and use direct and indirect proportion;

- interpret fractions, decimals and percentages as operations; and

- use ratio notation, including reduction to its simplest form and its various links to fraction notation.

Algebra

- distinguish the different roles played by letter symbols in algebra, using the correct notation;

- distinguish in meaning between the words equation, formula, identity and expression;

- manipulate algebraic expressions by:
  - collecting like terms;
  - multiplying a single term over a bracket, and by taking out common factors;
  - multiplying two linear expressions;
  - factorising quadratic expressions including the difference of two squares; and
  - simplifying rational expressions;

- set up and solve simple equations including simultaneous equations in two unknowns;

- solve quadratic equations;

- derive a formula, substitute numbers into a formula and change the subject of a formula;

- solve linear inequalities in one or two variables, and represent the solution set on a number line or suitable diagram;

- use systematic trial and improvement to find approximate solutions of equations where there is no simple analytical method of solving them;

- generate terms of a sequence using term-to-term and position-to- term definitions of the sequence;

- use linear expressions to describe the nth term of an arithmetic sequence;

- use the conventions for coordinates in the plane and plot points in all four quadrants, including using geometric information;

- recognise and plot equations that correspond to straight-line graphs in the coordinate plane, including finding gradients;

- understand that the form $y = mx + c$ represents a straight line and that m is the gradient of the line and c is the value of the y-intercept;

- understand the gradients of parallel lines;

- find the intersection points of the graphs of a linear and quadratic function, knowing that these are the approximate solutions of the corresponding simultaneous equations representing the linear and quadratic functions;

- draw, sketch and recognise graphs of:
  - simple cubic functions;
  - the reciprocal function $y = 1x$ with $x \neq 0$;
  - the function $y = k\,x$ for integer values of x and simple positive values of k; and
  - the trigonometric functions of $y = sin\,x$, $y = cos\,x$ and $y = tan\,x$;

- construct the graphs of simple loci;

- construct linear, quadratic and other functions from real-life problems and plot their corresponding graphs;

- discuss, plot and interpret graphs (which may be non-linear) modelling real situations;

- interpret the gradient at a point on a curve as the instantaneous rate of change; and

- generate points and plot graphs of simple quadratic functions, and use these to find approximate solutions.

Geometry and measure

- recall and use properties of angles at a point, angles at a point on a straight line (including right angles), perpendicular lines and opposite angles at a vertex;

- understand and use the angle properties of parallel and intersecting lines, triangles and quadrilaterals;

- calculate and use the sums of the interior and exterior angles of polygons;

- recall the properties and definitions of special types of quadrilateral, including square, rectangle, parallelogram, trapezium, kite and rhombus;

- recognise reflection and rotation symmetry of 2D shapes;

- understand congruence and similarity;

- use Pythagoras' theorem in 2D and 3D;

- use the trigonometrical ratios and the sine and cosine rules to solve 2D and 3D problems;

- distinguish between centre, radius, chord, diameter, circumference, tangent, arc, sector and segment;

- understand and use circle theorems;

- use 2D representations of 3D shapes;

- describe and transform 2D shapes using single or combined rotations, reflections, translations, or enlargements by a positive scale factor then use positive fractional and negative scale factors and distinguish properties that are preserved under particular transformations;

- use and interpret maps and scale drawings;
- understand and use the effect of enlargement for perimeter, area and volume of shapes and solids;
- interpret scales on a range of measuring instruments and recognise the inaccuracy of measurements;
- convert measurements from one unit to another;
- make sensible estimates of a range of measures;
- understand and use bearings;
- understand and use compound measures;
- measure and draw lines and angles;
- draw triangles and other 2D shapes using a ruler and protractor;
- use straight edge and a pair of compasses to do constructions;
- identify the loci of points, to include real life problems;
- calculate perimeters and areas of shapes made from triangles and rectangles and other shapes;
- calculate the area of a triangle using $\frac{1}{2} ab \sin C$;
- find circumferences and areas of circles;
- calculate volumes of right prisms and of shapes made from cubes and cuboids; and
- solve mensuration problems involving more complex shapes and solids.

Handling data, statistics and probability

- understand and use statistical problem solving process and handling data cycles;
- identify possible sources of bias;
- design an experiment or survey;
- design data-collection sheets, distinguishing between different types of data;
- sort, classify and tabulate qualitative (categorical) data and discrete or continuous quantitative data, including the use of two and three circle Venn diagrams to sort data;
- extract data from printed tables and lists;

- design and use two-way tables for discrete and grouped data;
- produce charts and diagrams for various data types;
- calculate median, mean, range, quartiles and inter-quartile range, mode and modal class;
- interpret a wide range of graphs and diagrams including frequency tables and diagrams, pictograms, bar charts, pie charts, line graphs, frequency trees and flow charts, and draw conclusions;
- recognise that graphs may be misleading;
- look at data to find patterns and exceptions;
- recognise correlation and draw and/or use lines of best fit by eye, understanding what these represent;
- compare distributions and make inferences;
- understand and use the vocabulary of probability and the probability scale;
- understand and use estimates or measures of probability from theoretical models (including equally likely outcomes) or from relative frequency;
- list all outcomes for single events, and for two successive events, in a systematic way and derive related probabilities;
- identify different mutually exclusive outcomes and know that the sum of the probabilities of all these outcomes is 1;
- know when to add or multiply two probabilities: if A and B are mutually exclusive, then the probability of A or B occurring is P(A) + P(B), whereas if A and B are independent events, the probability of A and B occurring is P(A) × P(B);
- use tree diagrams to represent outcomes of compound events, recognising when events are independent;
- compare experimental data and theoretical probabilities; and
- understand that if they repeat an experiment, they may – and usually will – get different outcomes, and that increasing sample size generally leads to better estimates of probability and population characteristics.

Assessment Arrangements

5. The assessment arrangements must enable mathematical knowledge, understanding and skills to be reported through an overall grade. There must also be the opportunity to assess the ability of candidates in Functional Mathematics and report this ability.

Assessment Objectives

6. The specification must require learners to demonstrate their ability as set out below.

Assessment Objectives		Weighting Foundation	Weighting Higher
AO1	**Use and apply standard techniques** Learners should be able to: • accurately recall facts, terminology and definitions; • use and interpret notation correctly; and • accurately carry out routine procedures or set tasks requiring multi-step solutions.	50%	40%
AO2	**Reason, interpret and communicate mathematically** Learners should be able to: • make deductions, inferences and draw conclusions from mathematical information; • construct chains of reasoning to achieve a given result; • interpret and communicate information accurately; • present arguments and proofs; and • assess the validity of an argument and critically evaluate a given way of presenting information. Where problems require students to 'use and apply standard techniques' or to independently 'solve problems' a proportion of those marks should be attributed to the corresponding assessment objective.	25%	30%
AO3	**Solve problems within mathematics and in other contexts** Learners should be able to: • translate problems in mathematical or non-mathematical contexts into a process or a series of mathematical processes; • make and use connections between different parts of mathematics; • interpret results in the context of the given problem; • evaluate methods used and results obtained; and • evaluate solutions to identify how they may have been affected by assumptions made. Where problems require students to 'use and apply standard techniques' or to independently 'solve problems' a proportion of those marks should be attributed to the corresponding assessment objective.	25%	30%

Scheme of assessment

7. The specification must allocate a weighting of 100 percent to external assessment.

8. Question papers must target both Foundation and Higher tiers.

9. Each scheme of assessment must allocate a minimum weighting of 25 percent, and a maximum weighting of 50 percent, to assessment without a calculator.

10. Assessments must allocate an appropriate weighting for the assessment of Functional Mathematics.